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1 June 2011

Online at https://mpra.ub.uni-muenchen.de/31221/
MPRA Paper No. 31221, posted 01 Jun 2011 08:43 UTC

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Loss Aversion, Social Comparison and Physical Abilities at Young Age*

Yasuhiro Nakamoto† and Masayuki Sato‡

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Abstract

We examine how physical abilities affect individuals' preferences. In particular, by incorporating social comparison into prospect theory, we directly estimate the degree of loss aversion from social comparison, a concept we term 'ALJ' (*Avoiding Loss relative to the Joneses*). Our main findings are as follows: (i) the participants who choose the physical education as the best subject exhibit a greater degree of ALJ than others; (ii) physical fitness influences the degree of ALJ; (iii) gender influences social comparison preferences; (iv) participants with a greater degree of ALJ do not respond to voluntary questionnaire; (v) the form of participants' ALJ is affected by the voluntary behavior of their parents. A comparison of ALJ with loss aversion in the original prospect theory reveals that they have different characteristics.

Keywords: Loss aversion, Risk aversion, Social Comparison, Physical fitness, Voluntary participation

JEL Classification Code:C90; C93; D12

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*The authors acknowledges financial support from a research project at Kyushu Sangyo University and Grant-in-Aid for Scientific Research, Japan Society for the Promotion of Science(JSPS).

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1 Introduction

Sport psychologists and behavioral scientists investigating a rich range of sports and cultural pastimes are increasingly using experimental models to gain theoretical insights into decision-making processes and actions in human behavioral systems (e.g., Tenenbaum and Eklund (2007), Davids et al (2002) and Davids et al (2005)), leading to many interesting conclusions. The present paper uses data on physical fitness, such as flexibility, strength, agility and speed, to examine the relationship between physical fitness, the surrounding environment in terms of motor abilities and individual preferences including loss aversion.

Loss aversion is an important element of individuals' preferences, showing that a one-dollar loss, from an initial reference position of zero own gain–loss, has a greater absolute effect on individual happiness than a one-dollar gain. Many articles based on prospect theory (Kahneman and Tversky, 1979) have offered evidence about loss aversion preference. The concept enables us to explain the large disparity often observed between the minimal amount that people are willing to accept (WTA) to give up a good and the maximal amount they would be willing to pay (WTP) to acquire it. In the original prospect theory, as well as in traditional economic theory, individuals act exclusively out of self-interest and maximize utility that depends on their own absolute consumption or income levels. Since Max Weber's work, it has also been well known that social comparison plays an important role in individual choices. As part of the striking development of neuroeconomics, Fliessbach et al (2007) and Dohmen et al (2011a) provide evidence about the neurophysiological foundations of relative income using functional magnetic resonance imaging (fMRI) techniques. Their common finding is that not only the absolute income but also the relative one influence reward-related brain activity. Many happiness studies in experimental fields examine the relation between individuals' happiness and that of others. Recent theoretical contributions incorporate social comparison by assuming that individuals care not only about their own consumption or income level but also about their society's average level (e.g., Abel (1990) and Dupor and Liu (2004)).

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The existing literature suggests that social comparison is a fundamental component of human behavior. In this paper, we assume that individuals compare their own gains and losses with those of others and extend prospect theory by incorporating this assumption. This implies that an individual feels loss if his or her gain is less than that of another, an insight that we incorporate into prospect theory. We directly estimate the loss aversion parameter including social comparison using switching analysis.[1] To distinguish between the loss aversion in the original prospect theory and that in our model, we term loss aversion with social comparison *Avoiding Loss relative to the Joneses* (*ALJ*).[2]

In addition to the preferences parameters, we focus on personal physical fitness and various components connected to ability. We have two reasons for this. First, it has long been known that physical and mental ability are extremely closely related, as shown in the considerable number of articles in the fields of medicine and psychology examining the psychological effects of physical fitness and physical activity. For example, physical activity and exercise are believed to alleviate some of the symptoms associated with mild to moderate depression and positively affect mental health. The evidence also suggests that physical activity and exercise might provide a beneficial adjunct to alcoholism and substance abuse programs, which improve self-image, confidence, well-being, sexual satisfaction, social skills and cognitive functioning and reduce the symptoms of anxiety.[3] Furthermore, in sport and health psychology, many studies have examined the effects of sports and motor abilities on personality, concluding that motor abilities, sports and exercise affect personality

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[1]For example, using switching analysis, Holt and Laury (2002) estimate the risk aversion parameter of the neoclassical utility function, while Tanaka et al (2010) and Liu (2011) estimate a loss aversion parameter as well as the risk aversion parameter in the original prospect theory.

[2]We make use of *Keeping Up with the Joneses* (KUJ) and *Running Away from the Joneses* (RAJ), which are used in other social comparison articles (e.g., Abel (1990) and Dupor and Liu (2003)).

[3]Green et al (2004) write about the mental health of children and adolescents and Biddle and Mutrie (2007) comprehensively examine the psychological effects of physical activity.

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through the relationship between coaches and athletes, social climate, match competition and the presence of spectators at matches. It has been acknowledged that athletes enjoy mental stability and have a low degree of neurotic inclination with high self-esteem. For example, Sonstroem and Morgan (1989) explain the positive effect of physical exercise on self-esteem in their exercise and self-esteem model.[4]

Second, we believe there is a relationship among preferences with social comparison, motor performance and competition. Competition is a human social behavior because our society is stimulated by the existence of others. People frequently engage in competition through sport. In particular, when the motor abilities of participants are measured in a class, the participants seem to be conscious of others in the class, which implies that motor performance may be affected according to the degree of participants' consciousness of others. If this is the case, we presume that motor performance is related to the degree of social comparison preferences. In addition, we focus on gender differences, because it is well known that competitive behavior and gender are closely related.[5] Hence, we are interested in whether gender affects the degree of ALJ.[6]

The above relationships are expected to be observed especially in the young because children have a greater tendency than adults to reveal a sense of emulation in simple competitions such as a 50 m dash, an endurance run and the long jump. In Japan's highly developed education system, the data on teenagers' motor performance are rich; nevertheless, it appears that using these data, the impacts on preferences have not yet been adequately analyzed, even though they constitute a suitable source for observing the potential relationship between social comparison and certain factors. Hence, we use the data on physical fitness collected by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), which studies the motor abilities of adolescents. Our data for the current paper cover 111 students

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[4]See Sonstroem et al (1993), Sonstroem et al (1994) and Marsh and Sonstroem (1995)

[5]For example, see Gneezy and Rustinichini (2004) and Gneezy et al (2009).

[6]As far as we know, the relation between gender and loss aversion in the original prospect theory has not been observed. See Tanaka et al (2010) and Liu (2011).

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aged 12–13 years, at Hetsugi Junior High School. The data include the degrees of agility, endurance, speed, muscular strength and flexibility. The students were also requested to voluntarily answer questions about their lifestyle, such as bedtime and hours of study. 73 students from Hetsugi Junior High School voluntarily answered the questions. In our experiment, we also asked whole participants (111 students) related to motor abilities: whether or not they do sport as their club activity, and whether or not they consider physical education to be their best subject.

In the current paper, we mainly examine the following three points. First, we investigate whether the degree of ALJ differs from loss aversion in the original prospect theory.[7] Second, we examine whether personal physical fitness and some components related to physical fitness affect ALJ. Third, we discuss the characteristics of those who participated in voluntary questionnaire and examine the relationship between parents' behavior and that of their children.

Our main findings are as follows. (i) The participants who choose the physical education as the best subject exhibit a greater degree of ALJ than the others (ii) Some types of physical fitness have an impact on the degree of ALJ, whereas those do not have an impact on loss aversion without social comparison. (iii) Gender largely influences preferences with social comparison, whereas it only slightly influences preferences taking no account of social comparison. (iv) Participants who exhibit a higher degree of ALJ tended not to respond to the voluntary questionnaire. (v) Participants' ALJ was related to parents' attitudes, as reflected in parents' willingness to complete a voluntary questionnaire; however, their loss aversion was not related.

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The remainder of the present paper is organized as follows. Section 2 describes the theoretical basis for our paper and presents an example of the difference between our theory and the original prospect theory. Section 3 examines the difference between ALJ and loss aversion, and the effects of physical fitness on these preferences. Section 4 makes further researches using our data. Section 5 concludes.

[7]The detailed procedure for the experiments is given in Section 3.

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2 The related literature

In the experimental field, there are some papers which are closely related to this paper. Tanaka et al (2010) and Liu (2011) conducted an experiment to elicit individual risk and loss preferences directly using switching analysis. In their experiments, the reference point is defined as an own gain–loss of zero using the original prospect theory. Tanaka et al (2010), who were the first to apply switching analysis in prospect theory, conclude that in villages with higher mean income, people are less loss averse; however, own household income is not correlated with the degree of loss aversion. Liu (2011) examines how risk and loss attitudes affect farm technology adoption decisions in China, finding that farmers with higher risk aversion or higher loss aversion adopt Bt cotton later.

Pore and Schweitzer (2011) directly interlink sporting performance and loss aversion using data from the PGA Tour, which tests for whether professional golfers' preferences show loss aversion. They demonstrate that professional golfers—including the best golfers such as Tiger Woods—hit birdie putts less accurately than they hit otherwise similar par putts, concluding that their preferences reflect loss aversion when the reference point is defined by par. Chiteji (2010) and Dohmen et al (2010) pay attention to cognitive and noncognitive abilities rather than physical abilities. Chiteji (2010) examines the relationship between individuals' health behavior and the "noncognitive" skills that are defined as the degree to which an individual is future-oriented and self-efficacious. It concludes that these skills are positively related to good health behaviors. Dohmen et al (2010) examine the relation between cognitive ability and risk aversion. They find that lower cognitive ability is associated with a greater level of risk aversion and more pronounced impatience.

Another strand of related literature considers gender differences and preferences.[8] Because individuals care about those with whom they are competing, social preferences and competition are related; therefore, we presume that the preferences with

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[8]See the detailed review of the relation between gender differences and preferences in Croson and Gneezy (2009).

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social comparison and gender differences are closely related.[9] This is because it has been well-known that gender affects competitive behavior. Gneezy and Rustichini (2004) use data on physical education of participants aged 9–10 to examine the relationship between gender and competition, and conclude that males attempt to play with many partners and compete with other males rather than with females.[10] Gneezy et al (2009) show that the surrounding environment is important for the link between gender and competition. They conclude that Maasai men opt to compete at roughly twice the rate as Maasai women, a finding that is consistent with those of other papers. The pattern is reversed among the Khasai, noting that the Maasai is a patriarchal society and the Khasai is matrilineal.

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3 The model

3.1 Loss aversion with or without social comparison

The empirical prediction from the loss aversion hypothesis in existing studies, including Kahneman and Tversky (1979), is that a loss of one dollar, from the initial reference position of a zero own gain–loss, has a greater absolute effect on individual happiness than a gain of one dollar. In contrast to the initial reference point of a zero own gain–loss, taking into account social comparison under which individuals care about, and respond to, another's gain, we assume that individuals are concerned with own gain–loss relative to another's gain–loss. This means that an individual feels loss if his or her gain is lower than this other's gain, even when own gain is obtained. We call this loss aversion with social comparison *Avoiding Loss relative to the Joneses* (ALJ).

We incorporate social comparison into the basic equation of prospect theory given

[9]In the case of preferences without social comparison, Tanaka et al (2010) and Liu (2011) conclude that gender does not affect the degree of loss aversion.

[10]In addition, Gneezy et al (2003) examine the relation between gender and competition in a winner-takes-all scheme.

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in a series of papers by Kahneman and Tversky (1979) Tversky and Kahneman (1992). When a set of consequences are simply assumed to be monetary outcomes, we assume that one receives x_1 with probability p and x_2 with probability $1-p$, in which $x_i(>0)$ $(i=1,2)$ are a set of money prizes with associated probabilities p and $1-p$.

Under a typical prospect that $x_i > X_{\text{others}} > x_j$ where $i,j=1,2$ and $i \neq j$, prospect theory with social comparison reduces to an expected valuation expression as in the original prospect theory:[11]

$$V(x_i|X_{\text{others}}) = \pi(p)v(x_1|X_{\text{others}}) + \pi(1-p)v(x_2|X_{\text{others}}), \quad i=1,2. \tag{1a}$$

$v(x_i|X_{\text{others}})$ $(i=1,2)$ is the subjective value of the outcome x_i and X_{others} is a reference point given by another's monetary prize. Probabilities are weighted by a nonlinear probability weighting function $\pi(\cdot)$ with $\pi(0)=0$ and $\pi(1)=1$.

Alternatively, when $x_i > x_j > X_{others}$ or $X_{others} > x_i > x_j$ where $i,j=1,2$ and $i \neq j$, the subjective value is specified as:

$$V(x_i|X_{\text{others}}) = v(x_2|X_{\text{others}}) + \pi(p)[v(x_1|X_{\text{others}}) - v(x_2|X_{\text{others}})], \quad i=1,2. \tag{1b}$$

From the general forms of our model in $(1a)$ and $(1b)$, we note the following three points. First, the original formulation of prospect theory allows for different curvature for the domain of own losses and of own gains. Instead, our model implies that the reference point given by another's monetary prize X_{others} separates the domain of losses from that of gains. Hence, the curvature differs according to whether or not an individual's monetary prize is greater than the other's gain. Second, if the curvatures given by the domains of losses and gains are the same, our model might reduce

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[11] A more general form is:

$$V(x_i|X_{\text{others},i}) = \pi(p)v(x_1|X_{\text{others},1}) + \pi(1-p)v(x_2|X_{\text{others},2}), \quad i=1,2.$$

That is, the other's monetary prize also changes under respective prospects; however, as depicted in our experimental design, we assume that the other's monetary prizes are the same under both prospects 1 and 2.

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to a kind of expected utility model with social comparison. Following the taxonomy given by Abel (1990) and Galí (1994), the reduced form of our model would be the well-known *Keeping (Catching) Up with the Joneses*. We return to this later, when specifying the utility function. Third, if we assume that $\pi(p) + \pi(1-p) = 1$, we show that the expressions $(1a)$ and $(1b)$ are the same as those in the original prospect theory.[12]

We now specify the subjective value $v(x_i|X_{\text{others}})$. Drawing on many studies that deal with social comparison, a standard subjective value is given by a piecewise power function $v(x_i|X_{\text{others}}) = (x_i - \alpha X_{\text{others}})^{1-\sigma}$ where α is the degree of social comparison and σ is the risk aversion parameter. Similar value functions have been used in the context of asset pricing (Abel 1990 and Galí 1994), growth models (Corneo and Jeanne 1997, Futagami and Shibata 1998), foundations of microeconomics (Clark and Oswald 1998), tax policy (Ljungqvist and Uhlig 2000) and equilibrium efficiency (Liu and Turnovsky 2005, Nakamoto 2009).[13] In the current paper, for tractability, we assume that the sign of α is positive, implying that the external impact of an increase in another's monetary prize is negative $\frac{\partial v(x_i|X_{\text{others}})}{\partial X_{\text{others}}} < 0$, which exhibits *Keeping Up with the Joneses*.[14] In addition, we simply assume that $\alpha = 1$.[15] Hence, in our model, $x_i \geq X_{\text{others}}$ is the domain of gains, while $x_i < X_{\text{others}}$ is the domain of losses.

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[12]Because the equation $(1b)$ is rewritten as $V(x_i|X_{\text{others}}) = \pi(p)v(x_1|X_{\text{others}}) + (1 - \pi(p))v(x_2|X_{\text{others}})$ $(i = 1, 2)$ using $\pi(p) + \pi(1-p) = 1$, we show that the equations $(1a)$ and $(1b)$ are the same.

[13]In addition to the piecewise power function, a popular value function incorporating social comparison is an iso-elastic form function: $v(x_i|X_{\text{others}}) = (x_i X_{\text{others}}^{\alpha})^{1-\sigma} = \left[x_i^{1-\alpha}\left(\frac{X_{\text{others}}}{x_i}\right)^{\alpha}\right]^{1-\sigma}$.

[14]In contrast to the sign restriction, when $\frac{\partial v(x_i|X_{\text{others}})}{\partial X_{\text{others}}} > 0$, preferences exhibit *Running Away from the Joneses*.

[15]This assumption allows us to reduce the number of questions that specify the preferences' parameters. In the next section, we present our experimental design.

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The simple piecewise power function used in the current paper is:

$$v(x_i|X_{\text{others}}) = \begin{cases} (x_i - X_{\text{others}})^{1-\sigma} & \text{if } x_i \geq X_{\text{others}} \\ -\lambda\left[-(x_i - X_{\text{others}})\right]^{1-\sigma} & \text{if } x_i < X_{\text{others}} \end{cases}, \tag{2}$$

where $\lambda(>0)$ is the value of ALJ and σ is the risk aversion parameter. The value of ALJ, λ, means that a higher value of ALJ indicates stronger ALJ. Where $\lambda > 1$, the value function is steeper in the negative than in the positive domain. In addition, because $\lambda \neq 1$, the function (2) has a kink around the reference point given by the other's monetary prize X_{others}. Next, the form of the risk aversion parameter implies risk loving for $\sigma < 0$, risk neutrality for $\sigma = 0$ and risk aversion for $\sigma > 0$. Assuming that the values of risk aversion σ are the same in the loss as in the gain domain, the utility for losses is just the negative reflection of the utility for gains, scaled down by λ. In particular, assuming that $|y - X_{\text{others}}| = |z - X_{\text{others}}|$ and $y > X_{\text{others}} > z(>0)$, the reflection is exhibited in the sense that:

$$v(z|X_{\text{others}}) = -\lambda v(y|X_{\text{others}}), \tag{3}$$

where y and z are own monetary prize. Thus, when λ is greater than unity, the loss of utility associated with giving up a valued good relative to another is greater than the utility gain associated with receiving it.

We now compare our model with the original prospect theory, which is useful for understanding the intuitions in the next section. The only difference between these models is the specification of the reference point. That is, our model faithfully reduces to the original prospect theory when the reference point is given by self status quo instead of another's monetary prize. In this case, the value function $W(x_i)$ in the original prospect theory is:

$$W(x_i) = \begin{cases} \pi(p)w(x_1) + \pi(1-p)w(x_2), & \text{if sign}\,(x_1) = -\text{sign}\,(x_2) \\ v(x_2) + \pi(p)[w(x_1) - w(x_2)], & \text{if sign}\,(x_1) = \text{sign}\,(x_2) \end{cases}, \tag{4}$$

where the piecewise subjective function is:

$$w(x_i) = \begin{cases} (x_i)^{1-\Sigma} & \text{if } x_i \geq 0 \\ -\Lambda\left[-(x_i)\right]^{1-\Sigma} & \text{if } x_i < 0 \end{cases}. \tag{5}$$

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Note that Σ is the risk aversion parameter and Λ is the loss aversion parameter. Hence, the reflection effect is:

$$w(-y) = -\Lambda w(y). \tag{6}$$

Finally, following earlier studies (e.g., Tanaka et al (2010), Liu (2011)), the non-linear probability weighting function is specified by:

$$\pi(p) = \exp(-(-\ln p)^{\alpha}), \tag{7}$$

where α is a parameter that determines whether or not the form of the value function is a well-known inverted S-shaped value function. If $\alpha < 1$, then $\pi(p)$ has an inverted S-shape, implying that consumers overvalue low probabilities of large gains or losses and undervalue high probabilities. However, if $\alpha = 1$, the function $\pi(p)$ becomes linear. Hence, the functional form given by $(1a)$ and $(1b)$ reduces to the expected utility function or a specified utility functional form.

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3.2 An example of loss aversion and ALJ

This subsection considers a series of choice problems to confirm the reflection property shown by (3) and (6), indicating that the decision may be changed by adding another's participation. Because we want to focus only on the reflection effect, we initially restrict the risk attitude by assuming $\sigma = \Sigma = 0$, which implies that an individual is risk neutral. Hence, the utility functions (2) and (5) become linear. In this simple setting, we consider the following choice problem:

Choice problem:	Choose between	
Choice A:	\$8$(=x_1)$ with p	\$6$(=x_2)$ with $1-p$
Choice B:	\$10$(=x_1)$ with p	\$4$(=x_2)$ with $1-p$

In this choice problem, the expected value of Choice A is that $\mathrm{EV_A} = 8p+6(1-p) = 2p+6$, while that of Choice B is that $\mathrm{EV_B} = 10p+4(1-p) = 6p+4$. For instance, if the probability is given by $p = 0.5$, the respective expected values are both 7.

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Case 1: Assume that the reference point is given by a zero own gain–loss. In the above-mentioned choice problem, the individual always gains regardless of whether A or B is chosen so the reflection effect in (6) is not produced. If he or she chooses Choice B, the decision implies:

$$\begin{aligned} & v(6)+\pi(p)[v(8)-v(6)] < v(4)+\pi(p)[v(10)-v(4)] \\ \Leftrightarrow & \frac{v(6)-v(4)}{v(10)+v(6)-v(8)-v(4)} < \pi(p) \\ \Leftrightarrow & 0.5 < \pi(p). \end{aligned} \tag{8}$$

The inequality (8) means that Choice B is selected if $\pi(p)$ is greater than 0.5.

Case 2: Let us consider that the individual's friend participates in this game and always obtains a certain gain $X_{others}(>0)$ irrespective of the choice of A or B. We assume that the risk-neutral individual cares about the friend so that his or her preference follows our model specification (1a) and (1b). We consider the case that the certain gain of the friend is less than any monetary prize in the choice problem. That is, $\$4 > X_{others}$. Hence, the individual's decision rule in this case would not be changed relative to that in Case 1 because the individual's monetary prize is equally scaled down by X_{others}:

$$\begin{aligned} & v(6|X_{others})+\pi(p)[v(8|X_{others})-v(6|X_{others})] < v(4|X_{others})+\pi(p)[v(10|X_{others})-v(4|X_{others})] \\ \Leftrightarrow & \frac{v(6|X_{others})-v(4|X_{others})}{v(10|X_{others})+v(6|X_{others})-v(8|X_{others})-v(4|X_{others})} < \pi(p) \\ \Leftrightarrow & 0.5 < \pi(p). \end{aligned} \tag{9}$$

Case 3: Suppose that $X_{others} = \$5$ to confirm how the ALJ parameter λ influences the individual's decision. If he or she chooses Choice B as in Cases 1 and 2, using (3) we can show that:

$$\begin{aligned} & v(6|5)+\pi(p)[v(8|5)-v(6|5)] < \pi(p)v(10|5)+\pi(1-p)v(4|5) \\ \Leftrightarrow & v(6|5) < \pi(p)\left[v(10|5)-v(8|5)+v(6|5)\right]-\lambda\pi(1-p)v(6|5) \\ \Leftrightarrow & 1 < 3\pi(p)-\lambda\pi(1-p). \end{aligned} \tag{10}$$

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Note that $\lambda(>0)$ indicates the degree of ALJ.

Before proceeding to the analysis of Case 3, we assume that $\alpha = 1$ in (7) so that the shape of the probability function is linear (i.e., $\pi(p) = p$). Furthermore, we assume that $p = 0.501$. In the choice problem, Choice A shows that the individual obtains \$8 with 50.1% and \$6 with 49.9%, while with Choice B, he or she obtains \$10 with 50.1% and \$4 with 49.9%. Hence, in both Cases 1 and 2, the individual prefers Choice B to Choice A.

Alternatively, the individual may select Choice B in Case 3, rather than Choice A. The equation (10) can be rewritten as:

$$\lambda < \frac{3 \times 0.501 - 1}{0.499} = \frac{0.503}{0.499} \approx 1.008016. \tag{11a}$$

As easily confirmed in (11a), the individual prefers Choice B to Choice A if $\lambda < 1.008016$, which is the same with those in Cases 1 and 2; however, if $\lambda > 1.008016$, the individual chooses Choice A, which is safer than Choice B. Furthermore, when the certain gain of the friend increases by \$7, the lower degree of ALJ causes a change in his or her decision:

$$\lambda < \frac{0.501}{0.499} \approx 1.004008. \tag{11b}$$

From these cases, we infer that even if an individual selects a risky choice without another, he or she may change the decision from the risky choice to a safe choice when another exists.

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4 Empirical study

4.1 Research design

The participants in our analysis are first-year students at Hetsugi Junior High School in Oita Prefecture, Japan, aged 12–13 years. The total number of students was 115, but four students were absent during our experiment. Hence, our data include responses from 111 students, comprising 69 boys and 42 girls. The data were collected at the school in June and December 2010.

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In June 2010, the motor ability tests were conducted. These were the 50 m dash, 20 m shuttle dash, standing long jump, grasping power, sidesteps, sit & up and sit & reach. These items are a long-established Japanese standard for measuring junior high school students' motor abilities. By using these data, which were collected according to the methods of Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT), we obtained data on physical fitness for agility, speed, endurance, muscular strength and flexibility. For example, from the 20 m shuttle dash data, we can confirm the degree of endurance because students repeatedly run between two lines 20 m apart for a given time until they give up, so that the more rounds run, the greater is the student's endurance. The sit & up and sit & reach tests enable us to measure the degree of flexibility. Sit & up measures participants' ability to lift themselves up from a position lying face down on the floor, while sit & reach tests anteflexion.[16] Table 1 provides the descriptive statistics comparing the results for Hetsugi Junior High School students with the national average for Japanese 12-year-olds.[17] Figure 1 shows the height and weight distributions of our participants. In addition to the physical tests, the students were invited to voluntarily answer questions about their lifestyle, such as bedtime and hours of study. Of our sample, 73 students answered these questions.

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In December 2010, we administered further questions and exercises to the same students at Hetsugi Junior High School to estimate the parameters of ALJ as well as loss aversion in the original prospect theory. Our experiment began at approximately 2 pm, and lasted four hours.

We constructed our full dataset in four stages. In the initial and final sessions, we adopted essentially the same method as the switching analysis of Tanaka et al (2010) and Liu (2011) in order to estimate the preferences' parameters directly. (i) Participants answered questions relating to their degree of loss aversion by selecting Choice A or Choice B for each lottery choice; in this initial session, we did not give

[16]Detailed explanations are available on the MEXT homepage at: www.mext.go.jp/a_menu/sports/stamina/05030101/001.pdf

[17]We use the latest data, for 2009, released by MEXT.

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any information about anyone else's gain defined as the reference point. The left panel of Table 2 indicates the summary questions in the initial session. Hence, the switching analysis in the initial session essentially follows Tanaka et al (2010) and Liu (2011); however, because, in our experiment, the participants were young and the sample size was large, we carefully explained to them the content and intent of the survey experiments, with the help of six teachers and two assistants. Furthermore, we contrived games about the switching analysis, using illustrations and the tools described below, to ensure that, as much as possible, our questions were correctly understood. First, we prepared booklets for each of our games and gave each student a booklet for each game. As shown in Figure 2, each pair of facing pages includes one question; Choice A is on the left page and Choice B is on the right page, along with circles labeled Y, G and P, indicating a yellow, green or pink ball. The participants circle their preferred Choice A or B. After drawing their circles, the participants wait in silence, and then simultaneously turn the page on our instruction. Second, we use a total of 10 balls with yellow, pink or green color. For example, in Figure 2 we have two yellow balls, six pink balls and two green balls. The role of the pink ball is important. In Choice A, when the ball's color which was randomly selected by us is yellow or pink, the participants obtain the large points (200 points), but when the color is green, they obtain the low points (100 points). Alternatively, in Choice B, the role of pink ball is changed, meaning that when the color of the selected ball is pink, the participants obtain the low points (10 points), rather than the large point as in Choice A. We explained to the students that after they make their choice, we would randomly draw one ball to determine their gains, and that the participants can then exchange their initial session points for gifts. However, we did not tell them what the gifts were.[18] (ii) We conducted some games to measure the students' memory and vocabulary, using stopwatches and blindfolds.[19] (iii) To investigate lifestyle and

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[18]We created our points/gifts exchange system because, under the rules of Hetsugi Junior High School, we could not reward participants with money.

[19]In these games, we estimate their degree of overconfidence and memory, but omit the results of these games here because they form the subject of another paper.

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demographics, we asked the students questions about their best subject, monthly allowance and their school club activities.

(iv) The switching analysis was repeated but in this session each pair of facing pages in the booklet included another's gain as well as the participant's own gain.[20] First, we must note that participants in the first session obtained points that could produce income and substitution effects in this final session. This implies that the choices of participants in this session may have been affected by points obtained in the initial session. Therefore, in this session we used a different currency, "ruby" rather than "point" used in the first session. This removed the income effects from points gained earlier. We then explained that rubies were to be exchanged for gifts, but that the gifts presented in exchange for rubies would be different from those exchanged for points.[21] In other words, we stressed that the gifts obtained in each section were not substitutes and that the participants were not allowed to exchange the gifts from one session with those from the other. We ensured by invigilation that participants answered the questions in this final session as seriously as they had in the initial session. Next, we introduced the concept of another's gain, as presented in each game's booklet, and explained that this "other" is a transfer student who would arrive Hetsugi Junior High School the following semester. At this stage, no student knows anything about the transfer student (e.g., sex or appearance). We explained that the new transfer student, not yet a member of the school, is to be given 500 rubies that will be exchanged for gifts. This ensures that participants' point of reference, defined by the other's gain, is 500 rubies. Finally, we focused on the timing of switching in the first and last sessions. As shown in Table 2, the gains and losses relative to each reference point in the last session are the same as those

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[20]Because we wished to avoid any bias from a learning effect from the initial session, we examined the degree of ALJ in the final session, which took place not less than two hours after the conclusion of the initial session.

[21]We did not inform participants of the nature of either type of gift. After all the games had been completed, we sent the participants their gifts according to the numbers of points and rubies each had obtained.

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in the first session, which means that the levels of own gain are simply scaled up by 500 rubies in the last session. In theory, we only changed the description, simply scaling up the numbers, so that participants' choices should not change if the "new student" with 500 rubies has no effect on participants. This would lead to the same parameter values in both sessions. If, on the other hand, the timing changed, social comparison would be seen to have an effect. Figure 3 shows the timing of switching from the safe option, Choice A, to the risky option, Choice B, where Figure 3a refers to the initial session and Figure 3b refers to the final session.

4.2 Analysis

We wish to confirm whether the parameters of preferences with social comparison differ from those in the original prospect theory. Using the t-test, the null hypothesis of equality of risk aversion with and without social comparison ($H_0 : \sigma = \Sigma$) is rejected at the 1% level. This implies that the risk attitude is influenced by the existence of other people's gains and losses. Similarly, $H_0 : \alpha = A$ is rejected at the 5% level where A is the probability function weight in the original prospect theory taking no account of the social comparison. The degree of loss aversion is not statistically different from that of ALJ. Using these parameters, Figure 4 shows the shape of the value functions $v(\cdot)$ and $w(\cdot)$ in (2) and (5).

We divide our participants into two groups, based on choice of "best subject", a question in our additional questionnaire (Table 3). Twenty-five participants answered that their best subject was physical education (PE=1). From the t-test, it is evident that the participants who chose physical education are more loss averse than the others. This result is consistent regardless of the specification of the reference point. For comparison, we pick those participants whose best subject is science or mathematics, chosen by thirty-five students (SciMath=1).[22] For participants who chose mathematics or science, there is no correlation between loss aversion and ALJ.

[22]We did not restrict participants to choosing a single "best subject"; however, no participants chose more than one "best subject".

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We also found that participants who chose physical education as their best subject are more risk averse with social comparison than the others, and those who chose science or mathematics are more risk loving with social comparison than the others.

Figure 4b shows the value functions $v(\cdot)$ and $w(\cdot)$ for groups (PE=0 and PE=1). For example, the value function $v(\cdot)$ for PE=1 has the steepest curvature in the loss domain whose curve is represented by Eq(5)PE in Figure 4.

Next, we examine the effects of physical fitness on ALJ, loss aversion and risk aversion. The correlations between the different physical fitness variables are given in Table 4, which confirms a high correlation between some variables. We divide our data into two groups, data on physical fitness and data on variables that are likely to affect physical fitness and whether the chosen best subject is physical education.

Table 5 shows that when the reference point is given by a transfer student's gain, some physical fitness variables affect the preference parameters, but when the reference point is given by self status quo, these parameters are almost unaffected. For example, columns (1) and (2) show that the greater the strength, the lower the degree of ALJ, while columns (4)–(6) show that the higher the speed, the lower the degree of risk aversion with social comparison. However, these results are not observed in the original prospect theory given in columns (3) and (7).

Finally, we analyze the effects of participants' attributes on preferences. To alleviate the problem of multicollinearity, Table 6 deals with the individual attributes that affect physical fitness and those such as gender and allowance (Money). The variable "Club" indicates that participants take part in individual sports represented by KARATE, JUDO and KENDO or not.[23] BMI is obtained from height and weight data. First, let us confirm the impacts of gender on ALJ and loss aversion. Columns (1), (2), (5) and (6) indicate that gender has an impact on preferences with social comparison: girls exhibit a higher degree of ALJ and are more risk averse with social comparison than boys. Columns (4) and (9) show that gender does not have an important impact on preferences in the absence of social comparison. Table 6

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[23]Group sports such as soccer and baseball did not almost affect whole preferences.

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concludes that choosing the best subject as physical education (PE) or participation in an individual sport has some impact on the preference parameters without social comparison. Columns (3), (4) and (7)–(9) show that participants who chose the best subject as physical education (PE) are more loss averse and more risk averse than the others. In addition, participants who participate in individual sports are less risk averse than the others.

5 Further research

5.1 Who respond to voluntary questionnaire?

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Whether the preferences of volunteer participants are representative of the population is an important topic in the experimental field because sample selection bias causes differences in preferences between voluntary participants and the general population.[24] Cleave et al (2011) examine differences in the social and risk preferences between the students who attend the laboratory and the general population in the trust game and the lottery choice game.[25] Their main finding is that the social and risk preferences of volunteer participants do not differ significantly from those of the population, concluding that the social and risk preferences of participants are representative of the population. We note that Cleave et al (2011) do not consider ALJ.

We are interested in how preferences affect the decision to participation in the voluntary questionnaire. Hence, we make use of the voluntary responses collected in May 2010. Table 7 presents our regressions of voluntary participation on preferences. From Columns (1)–(4) in Table 7, it can easily be confirmed that the degree of ALJ significantly affects participation in the voluntary questionnaire, showing that the greater the degree of ALJ, the less likely a participant will choose to respond to the voluntary questionnaire. It is noted that risk aversion with social comparison does

[24]See Heckman (1979) and Heckman et al (1998).

[25]The trust game elicits social preference, while the lottery choice game elicits risk aversion.

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not affect the decision, which is consistent with the results found by Cleave et al (2011). Furthermore, we can see that loss aversion without social comparison does not affect the participation decision.

5.2 Transmission from parents to their participant children

When focusing on willingness to take risks and willingness to trust others, Dohmen et al (2011b) test for transmission of attitudes from parents to children using direct measures of these attributes for both the children and their parents. They found that parents' attitudes play a role in shaping their children's attitudes. It is therefore interesting to incorporate the parents' ALJ. Thus, in March 2011, we sent the same questions asked in the final session to our participants' parents so that we could elicit parents' ALJ preferences.[26] We assumed that the reference point is a specific parent for our participants; however, no parent knew who the reference parent was. After receiving responses, we sent each respondent a gift certificate of the same cash value. As with our student participants, we gave the parents no information about the nature of the gift before receiving their completed questionnaires.

Because responding to our questionnaire was voluntary, only 26 parents did so where all respondents except one were mothers. We focus on the following two points: the relation between parents' willingness to participate in the voluntary questionnaire and their children's preferences, and the difference in ALJ between students and parents. Because participation and ALJ are closely related, we first reexamine whether the voluntary participation of parents is associated with their children's ALJ. Column (1) in Table 8 shows that children's ALJ is clearly positively associated with parents' participation with a p value=0.011, meaning that the children are more ALJ when their parents participate the voluntary questions. Even if individuals' attributes are introduced, Columns (2) and (3) show that the relation between parents' participation with their children's ALJ is consistent with Column (1). On the other

[26]We requested that only one parent answer the questions and noted which parent (father or mother) did so, and asked for a letter of acceptance.

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hand, the remaining children's preferences, given by Λ, σ and Σ, are not related to their parents' attitudes.

Finally, restricting the analysis to the 26 parents and their respective children, we examine the differences in ALJ and risk aversion with social comparison. Denoting the parents' preferences by the subscript p, our findings are that the parents have a greater degree of ALJ and are more risk averse than their children, while the probability function weight does not differ between children and their parents (Table 9).

6 Concluding remarks

This paper incorporates social comparison into the original prospect theory to examine the relationship between preferences with social comparison and physical fitness. Our main findings are as follows. First, we found that participants who chose the best subject as physical education exhibit a greater degree of ALJ and are more loss averse than the others. Second, we regressed ALJ and loss aversion with respect to the physical fitness and individual attributes. It appears that some physical fitness influences the degree of ALJ, whereas it does not influence the degree of loss aversion. In addition, we regress these preferences on the individuals' attributes, showing that gender influences preferences with social comparison, but does not influence those without social comparison.

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In addition to our main findings, we analyzed the relation between voluntary participation in our questionnaire and individuals' preferences. First, we found that the preference for ALJ significantly affects whether participants respond to a voluntary questionnaire, showing that participants with a greater degree of ALJ chose not to participate. However, there is no relationship between other preferences such as risk aversion and loss aversion and voluntary participation. Second, we examined the relationship between the voluntary behavior of parents and the preferences of their children. We found that the voluntary participation of parents was positively associated with the degree of their children's ALJ.

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Finally, we discuss the existence of multiple reference points. Loss aversion is a key element in the explanation of the large disparity observed between WTA and WTP. This large disparity may change with change in own gain position. For example, let us consider three familiar individuals who won 50 dollars on the most recent horse race. Then they would care about the others' gains as well as about their own. In the next race, suppose that one person loses 50 dollars, whereas the others win 50 dollars. In this case, what do they care about? Perhaps the loser is very sensitive as to whether or not his or her own gain is negative, meaning that his or her reference point is zero own gain–loss. On the other hand, the two people who won may be sensitive to each other. In that case, their reference point would be strongly weighted by the other's gain, not at a zero own gain–loss. The situation in which the gain occurs may determine own reference point. Let us consider another topic about Japan. After World War II, the level of GDP in Japan was very low, similar to those in developing countries. It seems that the great difference in GDP between Japan and the USA meant that people in Japan were not aware of the level of GDP in the USA. However, after decades of high economic growth in Japan, the level of Japan's GDP was second to that of the USA, and the Japanese people became acutely conscious of the USA. In the current period, the level of GDP in China and Japan is almost the same. Media reports in Japan express great concern about whether or not the level of GDP in Japan is larger than that in China.

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These examples suggest that multiple reference points and their changes are interesting. Following the notation in our paper, for example, we can present an additively separable value function with two reference points, $Z(x_i|X)$, as follows:

$$Z(x_i|X_{\text{others}}) = \beta W(x_i) + (1-\beta)V(x_i|X_{\text{others}}),$$

where β is a weight parameter, which would change according to own gain position.

Acknowledgments

We especially appreciate useful comments from Giacomo Corneo and Tomomi Tanaka. In addition, we thank Ryo Futami, Kyoko Hirose, Hiroki Iwata, Kunio Urakawa and

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Yushi Yoshida for their help in our experiments.

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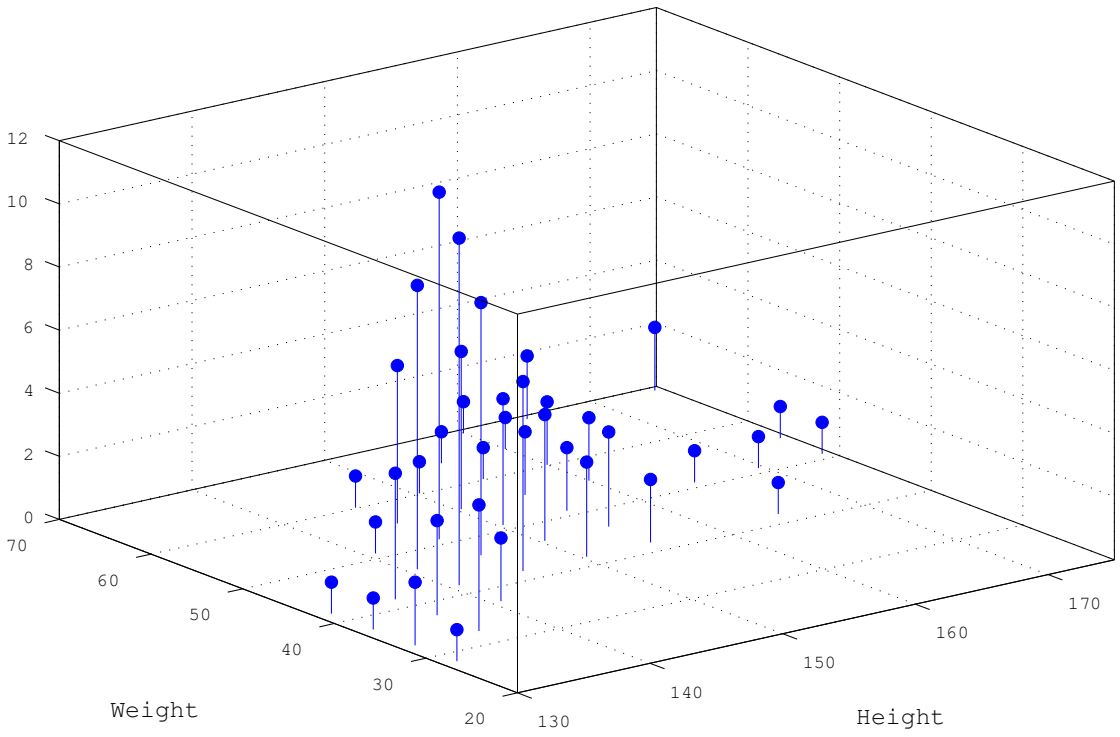

Figure 1: Participants' height and weight distribution

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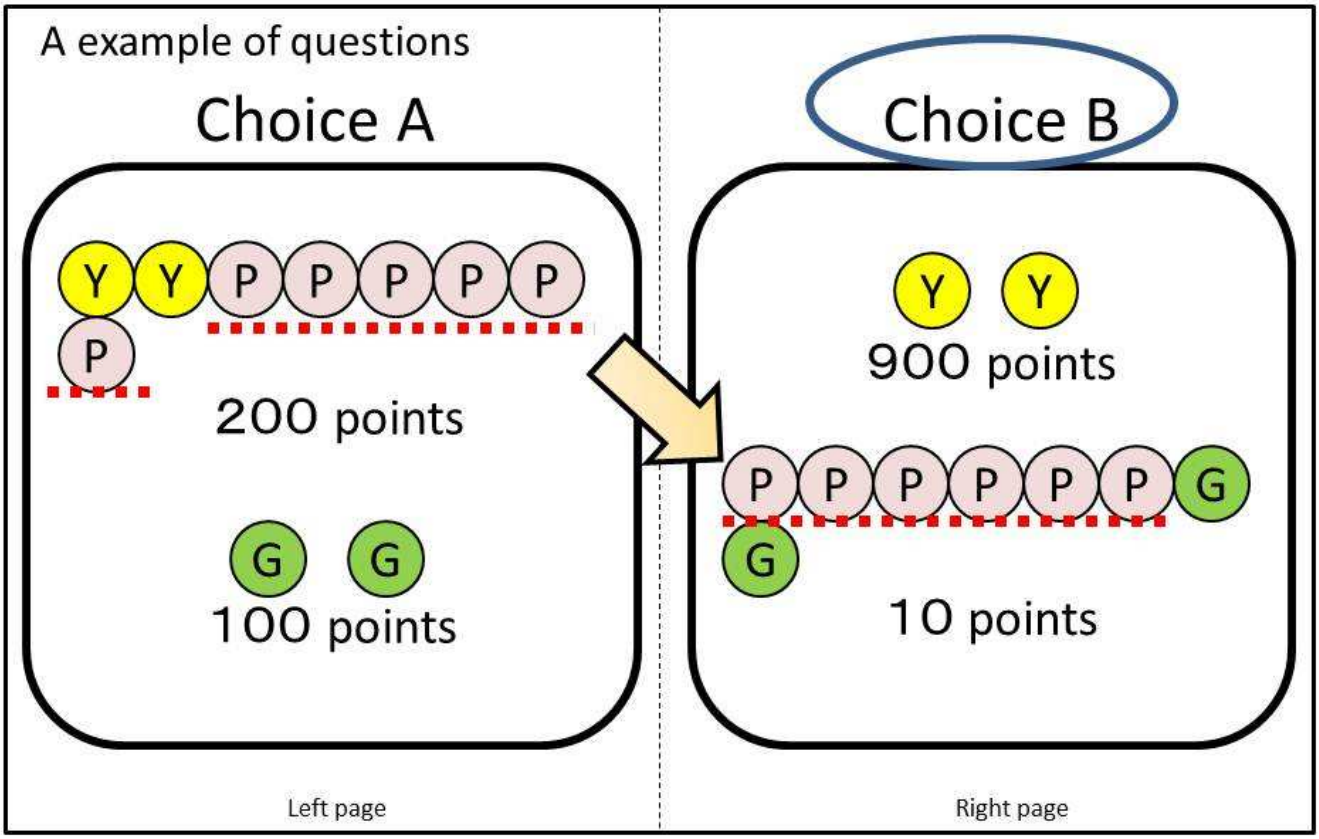

Figure 2: An example of the choice question

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Figure 3a: Switching analysis

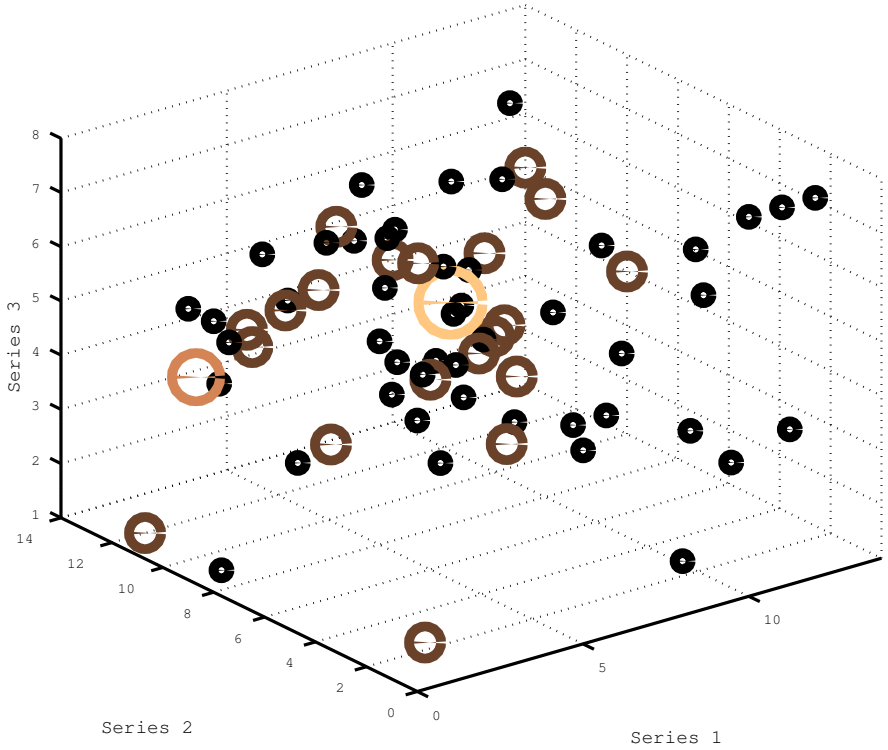

Figure 3b: Switching analysis with social comparison

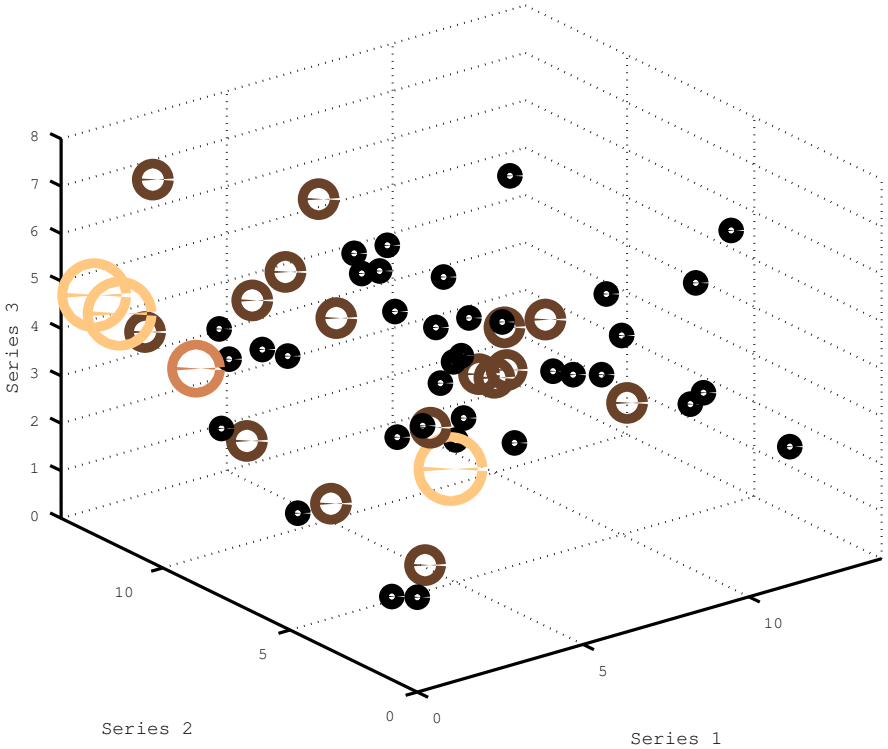

Figure 3: Results of the switching analysis

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Figure 4a: Prospect theory with or without social comparison

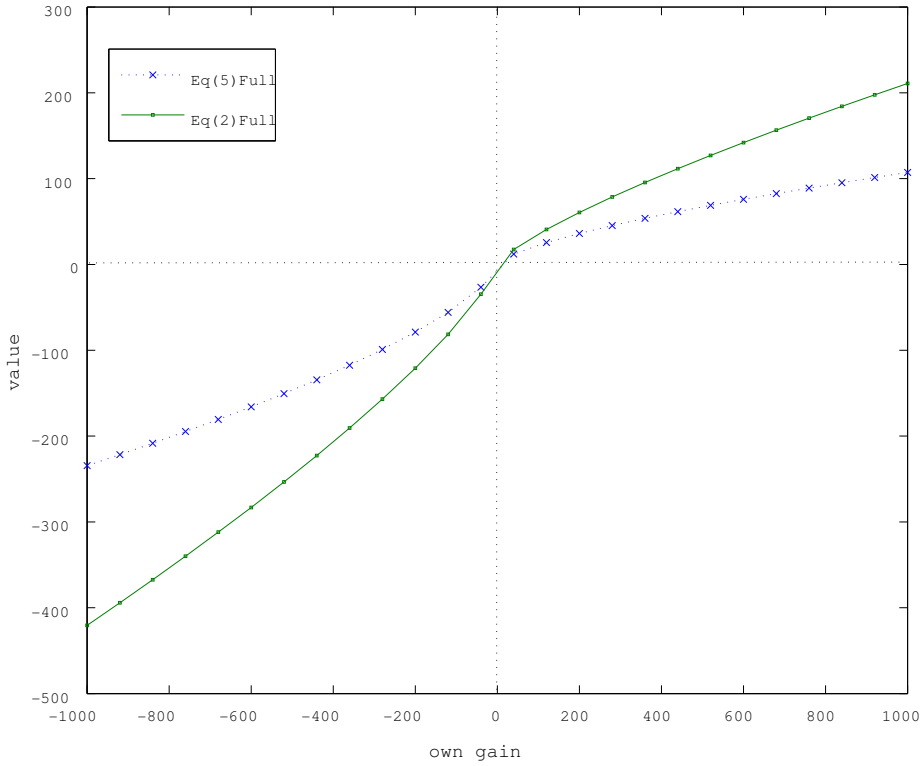

Figure 4b: Prospect theory, social comparison and physical education

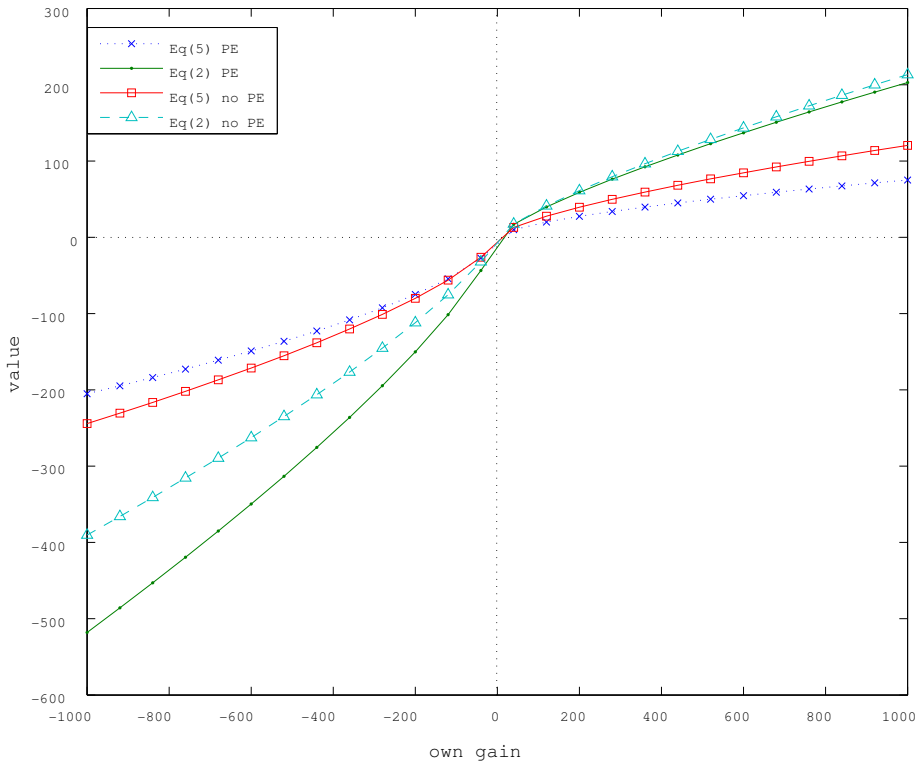

Figure 4: Shapes of value functions $v(\cdot)$ and $w(\cdot)$

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	Male				Female			
	Hetsugi		Japan		Hetsugi		Japan	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Height (cm)	152.9	8.97	152.7	7.88	150.3	6.14	152.1	6.01
Weight (kg)	43.8	7.59	43.5	8.83	44.8	8.78	43.2	7.63
Power (kg)	25.5	6.22	24.5	6.00	21.9	3.92	21.9	4.27
Sidestep (points)	46.9	6.70	48.2	6.54	39.7	8.23	44.0	5.64
Run (sec)	8.9	1.00	8.4	0.75	9.6	1.14	9.0	0.67
Shuttle (number)	70.9	17.45	69.3	21.94	47.0	19.68	50.7	17.61
Long jump (cm)	172.5	29.75	179.5	23.90	152.5	18.90	162.8	21.12
Ball throw (cm)	17.3	4.68	18.9	4.62	11.6	3.21	12.5	3.59
Sit up (cm)	22.6	5.88	23.7	5.56	20.8	6.66	20.3	5.14
Sit reach (cm)	35.6	7.89	38.7	9.20	41.6	8.12	42.6	9.48

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Table 1: The average for Hetsugi Junior High School and all Japan

To compare our participants with the average levels in Japan, we use data from the Ministry of Education, Culture, Sports, Science and Technology in Japan: http://www.mext.go.jp/english/

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The initial session without SC				**The last session (transfer gain is 500 rubies)**			
Choice A		Choice B		Choice A		Choice B	
Series 1							
40%	60%	10%	90%	40%	60%	10%	90%
500	20	900	10	1000	520	1400	510
500	20	950	10	1000	520	1450	510
500	20	1000	10	1000	520	1500	510
500	20	1050	10	1000	520	1550	510
500	20	1120	10	1000	520	1620	510
500	20	1200	10	1000	520	1700	510
500	20	1280	10	1000	520	1780	510
500	20	1360	10	1000	520	1860	510
500	20	1460	10	1000	520	1960	510
500	20	1560	10	1000	520	2060	510
500	20	1680	10	1000	520	2180	510
500	20	1800	10	1000	520	2300	510
500	20	2000	10	1000	520	2500	510
500	20	2300	10	1000	520	2800	510
Series 2							
90%	10%	70%	30%	90%	10%	70%	30%
250	150	410	10	750	650	910	510
250	150	420	10	750	650	920	510
250	150	430	10	750	650	930	510
250	150	440	10	750	650	940	510
250	150	450	10	750	650	950	510
250	150	460	10	750	650	960	510
250	150	470	10	750	650	970	510
250	150	480	10	750	650	980	510
250	150	490	10	750	650	990	510
250	150	500	10	750	650	1000	510
250	150	520	10	750	650	1020	510
250	150	540	10	750	650	1040	510
250	150	560	10	750	650	1060	510
250	150	580	10	750	650	1080	510
Series 3							
50%	50%	50%	50%	50%	50%	50%	50%
250	-40	300	-200	750	460	800	300
125	-40	300	-200	625	460	800	300
40	-40	300	-200	540	460	800	300
10	-40	300	-200	510	460	800	300
10	-40	300	-140	510	460	800	360
10	-60	300	-140	510	440	800	360
10	-80	300	-140	510	420	800	360
10	-80	300	-120	510	420	800	380

Table 2: Summary of responses to questions (note that we used the booklets as shown in Figure 6)

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PE	λ		Λ		σ		Σ	
Group	0	1	0	1	0	1	0	1
Mean	1.830	2.552	2.026	2.729	0.224	0.231	0.306	0.375
Std. dev	1.665	2.052	1.213	1.551	0.124	0.084	0.102	0.084
p-value	0.074		0.019		0.787		0.003	
SciMath								
Mean	1.991	2.003	2.323	1.894	0.220	0.236	0.333	0.297
Std. dev	1.657	2.036	1.411	1.073	0.103	0.140	0.099	0.105
p-value	0.974		0.113		0.506		0.080	

Obs=85 (PE=0) and Obs=25 (=1), while Obs=75 (Sci & Math=0) and Obs=35 (=1)

Table 3: The relation between preferences and best subject

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	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) PE	1.00						
(2) Speed	0.32	1.00					
(3) Quick	0.05	0.37	1.00				
(4) Flexibility	0.01	0.04	0.23	1.00			
(5) Strength	0.03	0.37	0.16	0.27	1.00		
(6) Endurance	0.33	0.50	0.45	0.01	-0.01	1.00	
(7) BMI	-0.16	-0.29	-0.15	0.15	0.22	-0.32	1.00

Table 4: Correlation of physical fitness with variables related to physical fitness

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	λ		Λ	σ			Σ
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Speed		0.225	−0.205	−0.025**	−0.027**	−0.037**	0.013
		(0.98)	(−1.16)	(−2.09)	(−2.26)	(−2.34)	(0.96)
Quick		−0.395**	0.108			−0.009	−0.004
		(−1.98)	(0.71)			(−0.66)	(−0.31)
Flexibility		0.161	−0.258		0.020*	0.020	0.017
		(0.85)	(−0.18)		(1.69)	(1.50)	(1.44)
Strength	−0.370**	−0.334*	0.077			0.015	−0.022*
	(−2.17)	(−1.71)	(0.51)			(1.12)	(−1.83)
Endurance		0.366*	0.158			0.018	0.001
		(1.70)	(0.95)			(1.20)	(0.06)
Cons	3.154***	1.973**	1.731***	0.289***	0.239***	0.191***	0.315***
	(5.70)	(2.36)	(2.70)	(8.81)	(5.43)	(3.36)	(6.18)
Obs	109	107	108	108	108	107	107

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Table 5: Regression of preferences on physical fitness

*, ** and *** indicate that estimated coefficients are significant at 10%, 5% and 1%, respectively. t-values are given in parentheses.

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	λ		Λ		σ		Σ		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
PE		0.793*	0.703**	0.762**		0.014	0.068***	0.071***	0.074***
(0=NO)		(1.92)	(2.39)	(2.55)		(0.49)	(3.07)	(3.25)	(3.19)
Club		−0.126		−0.409		0.021		−0.062**	−0.066**
(0=NO)		(−0.23)		(−1.04)		(0.54)		(−2.26)	(−2.18)
BMI		−0.006		0.153***		0.002			0.004
		(−0.07)		(2.61)		(0.31)			(0.84)
Sex	0.716**	0.814**		−0.464*	0.045**	0.044*			0.0003
(0=M)	(2.07)	(2.26)		(−1.78)	(2.02)	(1.79)			(0.02)
Money		−0.0002		−0.0001		0.000			0.000
		(−1.21)		(−0.85)		(−0.62)			(0.72)
Cons	1.728***	1.844	2.026***	−0.581	0.208***	0.177*	0.306***	0.314***	0.236***
	(8.20)	(1.19)	(14.42)	(−0.52)	(15.13)	(1.70)	(28.95)	(28.84)	(2.77)
Obs	110	107	110	107	110	107	111	111	108

Withdrawn by the author

Table 6: Regression of preferences on individuals' attributes

*, ** and *** indicate that estimated coefficients are significant at 10%, 5% and 1%, respectively. t-values are given in parentheses.

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		(1)	(2)	(3)	(4)
ALJ	λ	-0.387^{***}	-0.423^{***}	-0.425^{***}	-0.461^{***}
		(-3.09)	(-3.23)	(-3.15)	(-3.22)
Loss aversion	Λ		0.223	0.221	0.174
			(1.23)	(1.17)	(0.92)
Risk aversion with SC	σ			-0.570	-1.0286
				(-0.30)	(-0.50)
Risk aversion without SC	Σ			0.260	-0.612
				(0.11)	(-0.25)
The weight of probability function with SC	α				0.442
					(0.25)
The weight of probability function without SC	Λ				0.771
					((0.39)
PE					0.948
					(1.54)
Cons		1.491^{***}	1.088^{**}	1.139	0.759
		(4.40)	(2.38)	(1.32)	(0.49)
Obs		110	110	110	110

Table 7: The relation between voluntary participation and preferences

*, ** and *** indicate that estimated coefficients are significant at 10%, 5% and 1%, respectively. t-values are given in parentheses.

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	λ			Λ	σ	Σ
	(1)	(2)	(3)	(4)	(5)	(6)
Parent	0.943**	0.941***	1.024***	−0.028	0.011	0.0244
$(0 = NO)$	(2.59)	(2.63)	(2.84)	(−0.10)	(0.45)	(1.15)
PE			0.867**			
			(2.17)			
Club			−0.188			
(0=NO)			(−0.36)			
BMI			0.007			
			(0.09)			
Sex		0.713**	0.815**			
(0=M)		(2.12)	(2.34)			
Money			−0.0002			
			(−1.06)			
Cons	1.720***	1.455***	1.276	2.19***	0.222***	0.315***
	(8.77)	(6.33)	(0.85)	(14.58)	(16.85)	(27.51)
Obs	110	110	107	110	110	111

Withdrawn by the author

Table 8: The relation between parents' voluntary behavior and the preferences of their children

*, ** and *** indicate that estimated coefficients are significant at 10%, 5% and 1%, respectively. t-values are given in parentheses.

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	λ	λ_p	σ	σ_p	α	α_p	
Mean	2.614	3.921	0.221	0.452	0.609	0.578	Obs=26
Std. dev	1.988	2.971	0.116	0.119	0.105	0.148	
p-value	0.0695		0.0000		0.2961		

Table 9: Differences in preferences between the participants and their parents

Withdrawn by the author